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The Impact of Urbanization and Land-Use Change in Lincoln, Nebraska

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The Impact of Urbanization and Land-Use Change in Lincoln Nebraska

An Undergraduate Thesis

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Abstract

This study will take place in Lincoln Nebraska to investigate population density and urban encroachment onto agricultural lands. With urbanization on the rise we will inevitably face land use issues in the future. This research will investigate one strategy on how to build the city of Lincoln while using agriculture as a focal point. Keeping land sparing techniques in mind as we build will be an important component to saving enough land to grow food, shelter, and clothing for a growing population. One important question that will be looked at in this research is how urban expansion has consumed agricultural lands. This study will view past Landsat images and compare them to current images from the National Agriculture Imagery Program to help visualize urban encroachment. Looking at data from a span of nineteen years, from 1999-2018 will show just how fast Lincoln has expanded in just under two decades. By collecting population density information from the state, it can give a better understanding of how to predict future growth. This research utilizes government websites and professionals in the field of urban development to help reorganize relevant information and imagery to depict urban growth onto agricultural lands. Building up rather than the current practice of building out will be a more expensive, but a more sustainable way to develop urban infrastructure. By doing this, developers and city planners will be able to slow the rate of urban encroachment onto agriculture. Implementing this land sparing technique will allow Lincoln Nebraska to become a model for sustainable growth and development.

Introduction

This study investigates the effects of urbanization and land-use change in Lincoln Nebraska while focusing on agriculture. Looking closely at the impact of urban development on agriculture and modeling sustainable ideas for future development by analyzing past and present growth within an urban setting. Looking at current land use within an urban area and comparing it to arable land can give us an idea of how developers might go forward with urbanization. Another important variable that will be discussed is some of the constraint's developers may face within a local area such as building height, codes, zoning restrictions, etc. Looking at how new construction can mitigate natural or environmental hazards within urbanization will also be an element reviewed in this study. Important questions that will be reviewed within this research

include; How has urban expansion consumed agricultural lands? How can we slow down urban encroachment onto our agricultural lands in Lincoln Nebraska? What are some ideas for growing the city of Lincoln? Building up will be a more expensive, but a more sustainable way to develop our urban infrastructure. By doing this we will be able to slow the rate of urban encroachment onto agriculture by increasing population density. By implementing this land sparing technique Lincoln Nebraska will become a model for sustainable growth and development. I think this is a very relevant and important topic for the future because we need to figure out how to expand our agricultural resources while creating enough living space for a growing population so that future generations will have the same living conditions as the generations before them.

Making sure we will provide enough food, shelter, and clothing for a growing population can be very demanding on the land around us and it's important we proceed in a sustainable manner in order to continue living at the capacity we are now. Looking at geographic data can give us an idea of whether natural landscapes can give us an advantage or disadvantage in urbanization. This topic will model ideas that will help developers decide the best and most efficient ways to build while using hazard mitigation strategies. This research should take place because inevitably we will be forced to find a middle ground between food, water, shelter, and clothing. All of which directly relate to land use and population growth. Granted, Lincoln Nebraska may not need to worry about this for a long time, but in other already overly-dense areas we may need to take action sooner than later. Being resourceful now can extend the overall well-being of future generations for much longer than if we wait until it is already a serious problem. Humans tend to change on the precipice of disaster, but it will be too late in this case and may result in famine, displacement, war, or disease. Currently there is limited knowledge of how to best reconcile urban development with agricultural and land conservation. Learning how

to implement land sparing development will pose beneficial to both aesthetics and carbon sequestration but could create problems when trying to maximize agriculture.

Background

The most commonly cited definition of sustainable development has been drawn from the Brundtland report of well over a decade ago (McManus, 2014). Its broad concern that actions taken today should not compromise future generations remains a sound starting point. However, it is such a broad definition that the term "sustainable development" has often been seen to mean different things to the different interest groups that use it (Jenks, 2015). Sustainable development is described as development that does not require resources beyond its environmental capacity, is equitable, promotes social justice, and is created through comprehensive decision-making procedures (Jenks, 2015). Different components with the potential to influence the sustainability of urban form are documented by the size, shape, density, and compactness of cities; processes of intensification and decentralization; land use, mixed uses, layout, building type, and green open spaces. As we know, sustainability in urban planning varies from country to country. (Jenks, 2015).

66% of the world's population is predicted to live in cities by 2050 according to the United Nations Department of Economic and Social Affairs, Population Division 2014. The challenge of integrating urban growth with biodiversity and agricultural conservation demands a closer look (Collas, 2017). People benefit from urban biodiversity through the enhanced delivery of ecosystem services, including air filtration, local climate regulation, water infiltration, and human health and well-being (Bolund & Hunhammar 1999; Fuller et al. 2007). This will be an important aspect when looking at densely populated areas.

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With the rapid advancement of urbanization and development of urban industries we have seen more and more people moving to cities. We have seen a large increase in urban population and expect to see that number rise in the future. Therefore, it is more important than ever to be mindful of how we urbanize with population growth. We have also seen the emission of waste gas discharged from urban industries and residents' thereby aggravating atmospheric pollution (Zhenhua, 2017).

For the first time in history we are seeing urbanization being recognized as an essential part of strategic discussions on the sustainability front of our planet. The UN roadmap for achieving sustainability has recognized urbanization as a driving force for development and prosperity within the Agenda 2030 for Sustainable Development (Kacyira, 2017). Urbanization is one of the most affordable and accessible policy tools we can use to realize a peaceful, inclusive, and sustainable development.

Unfortunately, urbanization has not been fully applied at all levels of governance (Kacyira, 2017). Much of the policy debate about urbanization has been disrupted by several factors, including an overreliance on a narrow, sector-specific approach, such as housing, infrastructure, or governance. By looking at our own local governance we can begin to paint a picture of what drives contractors to build in certain areas and at what rates. Another large component to why we aren't approaching urban development more sustainably is due to insufficient attention to the consequences of urbanization gone wrong, such as slums and informal settlements, ghettos, pockets of urban poverty next to vibrant city centers, and social strife and conflict (Kacyira, 2017).

Sustainability has been on the political agenda for more than two decades, as demonstrated by the organization of international summits such as the United Nations

Conference on Environment and Development in Rio de Janeiro (1992) and the United Nations Climate Change Conference in Copenhagen (2009) (Rérat, 2012). Smart development means a synthetic classification and positive feedback of good comprehensible match among resource allocation, spatial pattern, and comprehensive performance. It is a logical reconstruction of economic new normal development based on the perspective of reasonable stock of land and orderly migration of population (Chen, 2018).

There is a major danger in assuming that the problems may be much the same across various countries. There is also a danger of assuming that widely held doctrines of urban planning, the signs and symbols of globalization, or the images of modernism mean that differences between regions and cultures is narrowing to insignificance (Noe, 1985). Also, classifying the world into developed and developing countries can be risky. There are many similar characteristics, as well as significant differences, but shouldn't be assumed that certain applications would produce the same solution. There are clear differences between many countries, from the poor to the very rich. There is also variation in the overall sustainability of these countries when their ecological footprint is considered (Jenks, 2015). Because there are many similarities and differences between countries, there are also specific cultural and physical differences that need to be kept in mind. Cities with strong economies that enable investment in transport infrastructure and property, and those that have laissez-faire controls and a dominance of market forces are at one end of the spectrum. Then there are those cities where the informal subdivision is dominant, social segregation and inequalities are substantial, and where self-help may be the best way to obtain housing (Jenks, 2015). Despite the wide range of differences, several common themes and distinct differences prevail. Key issues in relation to sustainability range from density and transport, to encroachment on agricultural land and urban sprawl.

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A large proportion of the nation's cropland that produces high market value agricultural products is within close proximity to fast growing metropolitan areas. The conversion of high value cropland to urban land uses is taking place within and adjacent to metropolitan areas while cropland is increasing in nonmetropolitan areas with marginal lands (Greene, 1995). It is important to examine the spatial pattern of the nation's high market value cropland in relation to fast growing metropolitan regions, areas of increasing cropland, and areas with marginal lands. A case study of a rapidly urbanizing region in northern Illinois demonstrates the rate at which high value agricultural land is being lost to urban encroachment (Greene, 1995). These findings raise several policy questions that are difficult to address in the absence of national farmland protection policies (Greene, 1995).

The relationship between densification policies and the rate of loss of agricultural and rural land on the urban boundaries, the incidence of urban agriculture and the availability of green and open space within the city is similarly complex (Mathey, 2000). The benefits of slowing down the rate of urban expansion through promoting higher density settlements are particularly great in those world regions where rates of urban growth are high, arable land per capita rates are low, and agricultural productivity growth rates are low (Jenks, 2015). If densification occurs using instruments that lower the availability of domestic space (e.g. reduced plot sizes, higher minimum plot/built area ratios), the effect on urban agriculture could be very serious for the poor, for whom it is a basic element in their survival strategy. How to both preserve access to this strategy and how to increase population density is a major problem for cities with a low level of economic development (Jenks, 2015).

The same deliberations govern the relationship between increasing population density and open green space provision. Per capita open and green space rates are often very low in cities

in developing countries and where these spaces exist, they are often poorly maintained, covered with waste, or are frequently squatted on (Jenks, 2015). It is difficult to see how densities and green and open space rates can be increased at the same time without using the modernist, high-rise, high-density solutions implemented in countries such as Singapore and Hong Kong and the radical approaches which are regarded as socially and politically unacceptable in many countries (Jenks, 2015). Densification of inner-city areas is not desirable given existing rates of overcrowding and can only lead to a further weakening of already horrendous social and environmental conditions. The ability to realize the gains of a more reasonable division of space within the existing building stock that are claimed for increasing population density policies in developed countries do not apply in developing countries (Jenks, 2015). This is because they are at an earlier stage in the demographic transition process. The rate of household formation is high because of high rates of natural increase and rural to urban migration. Families are large though average family sizes are falling, the number of single-parent households is high, particularly amongst the poor. The number of young people of childbearing age is high and the numbers of the old are low (Jenks, 2015). As in developed countries, attempts to manipulate urban form to achieve sustainability benefits have been limited. The reasons for this include the shift from master planning to strategic planning, and from physical planning to socio-economic planning, and a shift in the focus of urban professional practice towards urban restructuring at the neighborhood level (Jenks, 2015).

Methodology

This study is comprised of multiple literature reviews along with analyzing Landsat data on urban growth of Lincoln, population growth census data, population density data, and raw data on cropland converted over the last nineteen years in Lincoln Nebraska. By using

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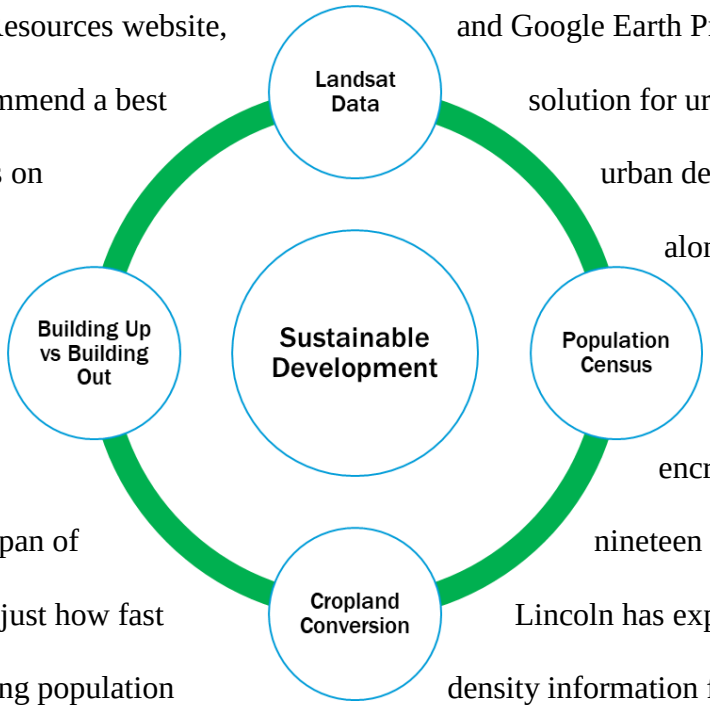
population growth census data from the U.S. census bureau database, combined with Landsat data and cropland conversion data found in the City of Lincoln's GIS website, the Nebraska Department of Natural Resources website, and Google Earth Pro helped to predict growth and recommend a best solution for urban planners. Viewing Landsat images on urban development for a specific region located along the northern boundary of the city of Lincoln in Lancaster county gave a good visualization of urban encroachment. Looking at data from a span of nineteen years, from 1999-2018 helped show just how fast Lincoln has expanded in under two decades. By collecting population density information from the state, it helped give a better understanding of how to predict future growth. Landsat imagery was examined in 1999 and compared to the National Agriculture Imagery Program in 2018. This helped create a good sample depicting urban growth over possible agriculture in Lincoln Nebraska. By collecting quantitative data from multiple sources, this aided in examining population growth within the city. By utilizing government websites and talking to professionals in the field of urban development helped to reorganize relevant information and imagery to depict urban growth onto agricultural lands. By comparing and contrasting growth outward land sparing techniques are easily demonstrated by building up rather than out. Utilizing academic search premiere at UNL libraries proved to be very useful in finding data relating to this topic. Lastly, reaching out to previous professors was helpful for obtaining the best data for my specific location to make relevant correlations and conclusions.



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Results

In just a nineteen-year span roughly 68,808 people have moved to Lincoln Nebraska making an impact on the surrounding agriculture and density of the city. The data was found in figure 1 by using the U.S. Bureau of the Census Population Estimates for Lincoln NE and comparing 1999 to 2018. This bar graph shows population growth data. These population growth estimates show that Lincoln in 1999 had roughly 215,928 people, while in 2018 it had 284,736 people. Lincoln grew by about 68,808 people according to U.S. Bureau of the Census Population Estimates for Lincoln NE. Looking at the sample data depicting the northern boundary of the city of Lincoln, it can be said that roughly 58,459,780 square feet of agriculture has been urbanized and therefore unfit to grow food or resources at a large scale used by a growing population. This data was found by taking measurements of Landsat images in Google Earth Pro in 1999 and comparing those measurements to the National Agriculture Imagery Program image from 2018. The final data set in the population density graph below was acquired through the American Community Survey

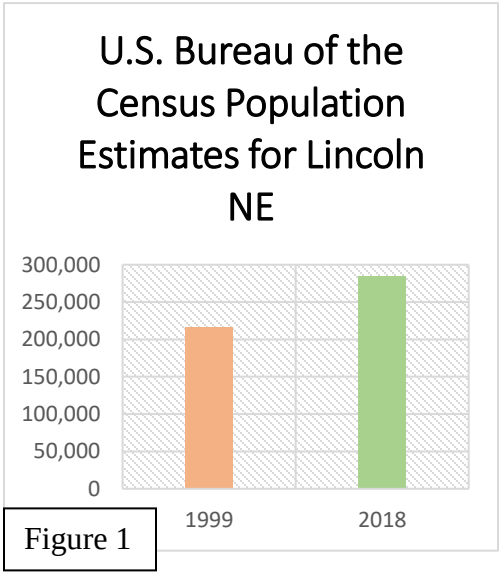
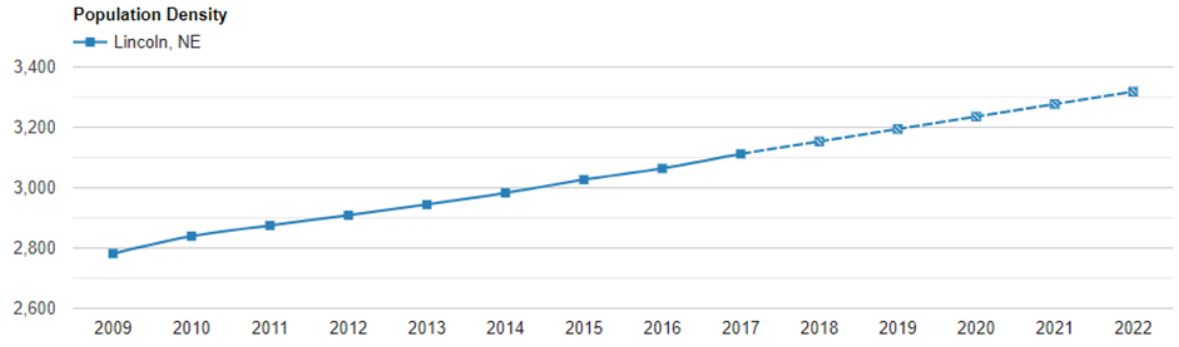


Figure 1



(ACS). The last measured population density for Lincoln, NE was 3,112 people per square mile in 2017. Lincoln, NE experienced an average growth rate of 1.48% from their first statistic recorded in 2009. If you compare this trend to our neighbors in Omaha, NE we see that they have only experienced a 0.57% growth rate due to the fact that they are a more densely populated city with 3,644 people per square mile in 2017. If past trends continue, the population density of Lincoln Nebraska will be 3,318 people per square mile by 2022. Population density was computed by dividing the total population of each year by land area per square mile. By continuing to grow our population density trend upward we can help mitigate agricultural consumption from urban development. By modifying Lincoln's growth outward onto our agricultural lands, developers should build the city upward at a faster rate than they are currently.

Discussion

Urbanization is one of the most affordable and accessible policy tools we can use to realize a peaceful, inclusive, and sustainable development (Rérat, 2012). One model found through this research was the UN roadmap for achieving sustainability. This currently provides guidance for companies and contractors on how to integrate sustainability related goals and strategies across the organization. Best practices are illustrated and the value that can be created across five stages of sustainability integration is highlighted within the model. The rapid development of urbanization has brought serious environmental damage and pollution and has negatively affected people's health (Zhenhua, 2017).

While trying to find what was already in place for the city of Lincoln as far as mitigating urban encroachment, I came across the Lincoln/Lancaster County 2040 Comprehensive Plan. It discussed strategies for greater downtown by encouraging higher density development with parking areas at the rear of buildings, below grade, or on upper floors of multi-use parking

structures (Minner, Et. al 2016). It also mentioned using mixed use redevelopment nodes and corridors to maximize population density without expanding onto more land. In areas that will be heavily urbanized in the future, city planners and policymakers should adopt approaches that follow a land-sparing strategy and that keep large blocks of greenspace free from development (Soga, 2014).

Urbanization is one of the most important global trends of the twenty-first century. Cities are now home to more than half of the world's population, their numbers growing continuously. By 2050, two-thirds of the world population will be living in urban areas (Kacyira, 2017). We need to do what we can to implement policy that drives urban development so that we are saving resources and protecting the environment. One policy I came across discussed development boundaries as a strategy. The basic function of urban development boundaries is to assist in the management of city development by restricting urban development to a clearly defined, geographically connected region to prevent unplanned city expansion (Jiang, 2016). By strategizing where we put the construction of ecological civilizations will be a very important aspect for future development if we want to preserve our resources and maximize potential. By fully promoting resource conservation and strengthening the protection of agricultural lands within the environment we can begin to see a better future. During the process of promoting urbanization and industrialization, it is necessary to deal with issues of natural resources seriously and make the effort to realize ecological urbanization (Zhenhua, 2017). There have been many discussions on how we can utilize sustainable development within local urbanization including issues related to agriculture, but how we approach these issues here in Lincoln Nebraska could determine the well-being of this great city for generations to come.

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References

Bolund, P. & Hunhammar, S. (1999). Ecosystem services in urban areas. Ecological Economics, 29, 293– 301.

Chen, X., Wei, L., & Zhang, H. (2018). Spatial and Temporal Pattern of Urban Smart Development in China and Its Driving Mechanism. Chinese Geographical Science, 28(4), 584–599. https://doi-org.libproxy.unl.edu/10.1007/s11769-018-0976-0

Collas, L., Green, R. E., Ross, A., Wastell, J. H., Balmford, A., & Bennett, J. (2017). Urban development, land sharing and land sparing: the importance of considering restoration. Journal Of Applied Ecology, 54(6), 1865-1873. doi:10.1111/1365-2664.12908

Fuller, R., Irvine, K., Devine-Wright, P., Warren, P. & Gaston, K. (2007). Psychological benefits of green space increase with biodiversity. Biology Letters, 3, 390– 394.

Greene, R. P., & Harlin, J. M. (1995). Threat to high market value agricultural lands from urban encroachment: A national and regional. Social Science Journal, 32(2), 137. Retrieved from http://libproxy.unl.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=aph&AN=9505167600&site=ehost-live

Jenks, M., & Burgess, R. (2015). COMPACT CITIES: *Sustainable urban forms for developing countries*. Place of publication not identified: TAYLOR & FRANCIS.

Jiang, P., Cheng, Q., Gong, Y., Wang, L., Zhang, Y., Cheng, L., … Chen, D. (2016). Using Urban Development Boundaries to Constrain Uncontrolled Urban Sprawl in China. Annals of the American Association of Geographers, 106(6), 1321–1343. https://doi-org.libproxy.unl.edu/10.1080/24694452.2016.1198213

The Impact of Urbanization and Land-Use Change in Lincoln Nebraska

By: Andrew Rose

Kacyira, A. K. (2017). Urbanization: Emerging Challenges and a New Global Urban Agenda. Brown Journal of World Affairs, 23(2), 87–102. Retrieved from http://libproxy.unl.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=aph&AN=124009985&site=ehost-live

Mathey, S., & Zagar, D. (2000). The neighborhood distribution effect in visual word recognition: Words with single and twin. Journal of Experimental Psychology. Human Perception & Performance, 26(1), 184. https://doi-org.libproxy.unl.edu/10.1037/0096-1523.26.1.184

McManus, P. (2014). Defining sustainable development for our common future: a history of the World Commission on Environment and Development (Brundtland Commission). Australian Geographer, 45(4), 559–561. https://doi-org.libproxy.unl.edu/10.1080/00049182.2014.953722

Minner, M., Abendroth, M., Kohmetscher, J., & McKinstry, T. (2016). LPlan2040. Retrieved from http://lincoln.ne.gov/city/plan/lplan2040/index.htm

Noe, S. V. (1985). Cities, Poverty and Development: Urbanization in the Third World (Book). Studies in Comparative International Development, 20(2), 101. Retrieved from http://search.ebscohost.com.libproxy.unl.edu/login.aspx?direct=true&db=aph&AN=6988552&site=ehost-live

Rérat, P. (2012). Housing, the Compact City and Sustainable Development: Some Insights From Recent Urban Trends in Switzerland. International Journal of Housing Policy, 12(2), 115–136. https://doi-org.libproxy.unl.edu/10.1080/14616718.2012.681570

Soga, M., Yamaura, Y., Koike, S., Gaston, K. J., & Rhodes, J. (2014). Land sharing vs. land sparing: does the compact city reconcile urban development and biodiversity conservation? Journal of Applied Ecology, 51(5), 1378–1386. https://doi-org.libproxy.unl.edu/10.1111/1365-2664.12280

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Zhenhua TIAN. (2017). Study of Coordinated Development of Urbanization and the Environment. Agricultural Science & Technology, 18(8), 1505–1520. Retrieved from http://libproxy.unl.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=aph&AN=126375364&site=ehost-live